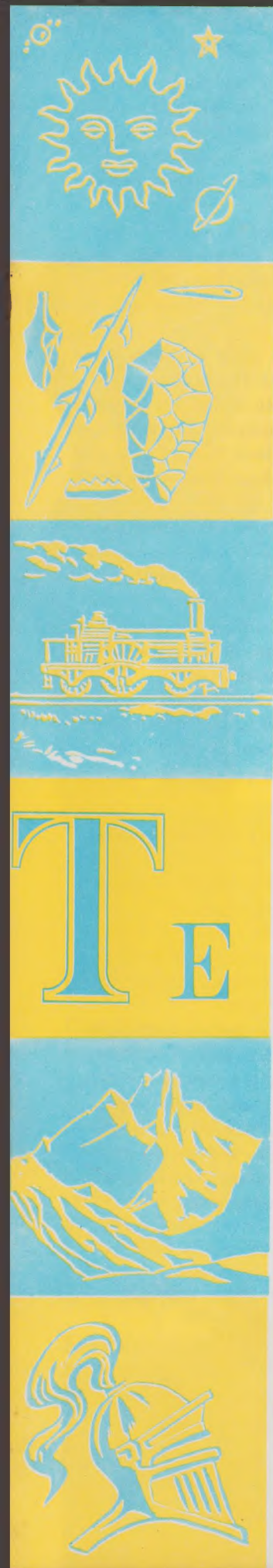


KNOWLEDGE

NO. 185 VOLUME 16 The colour magazine which grows into an encyclopaedia EVERY MONDAY 2/-



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T T R E E S

TREES are the largest of all living organisms. Mature specimens of many species attain a height of 150 feet, while the occasional giant of the largest species reaches over 350 feet. Such stature demands great structural strength, and this is provided by the tree's enduring woody trunk, or *bole*. Every tree, whether large or small, has a bole, and in many species the bole is of commercial value as timber.

Roughly 100 species of trees are found growing commonly in the British Isles. About half of these are native trees, and half are species introduced from abroad. Specimens of many more species are occasionally found in parks and botanical gardens, but these are mostly exotic varieties imported from other countries, which require special care to survive in the British climate.

Because they have seeds, all trees are members of the vast botanical group of seed-bearing plants, the Spermatophytes. Since, however, there are two quite distinct types of female flower, some trees belong to the Class Gymnospermae, while others belong to the Class Angiospermae.

The Gymnospermae is quite a small Class and consists chiefly of the cone-bearing trees, which are known as conifers. The Angiospermae is much larger and has two sections, one containing the broad-leaved trees so familiar in parkland and countryside and the other containing the palms which grow in tropical and subtropical countries.

The conifers

The conifers include cedars, cypresses, larches, pines, spruces, firs, and giant sequoias. Yews and junipers are also called 'conifers', although the fruits which they bear are berries rather than cones. The conifers have been called 'living fossils', for they are little different today from the first Gymnospermae which grew 300 million years ago.

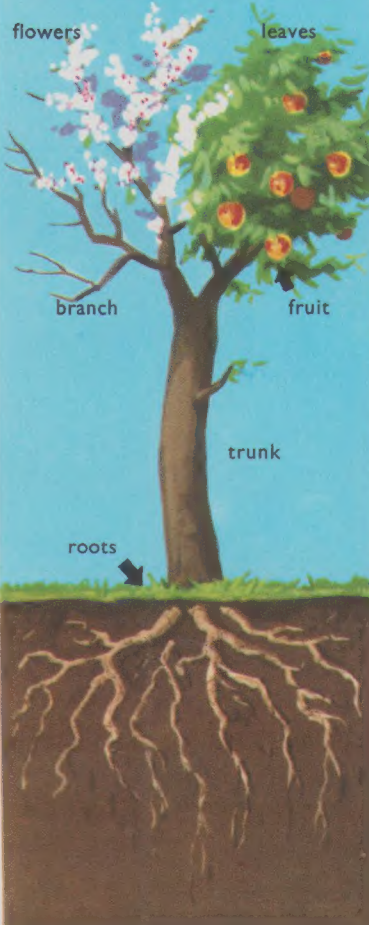
With the exception of the larch, all conifers are evergreens. The leaves of most species are long, narrow, and needle-like; they are sometimes arranged along a shoot and sometimes arranged in clusters. Each year large numbers of the needles fall off and are replaced by new ones.

The flowers of the conifers are either male or female. In many species both types of flower grow on the same tree, and these species are said to be *monoecious*. In other species – the yew, the juniper, and the sequoia, for example – the male and female flowers grow on separate trees. Such species are said to be *dioecious*, and in a plantation of these trees both male and female specimens are found.

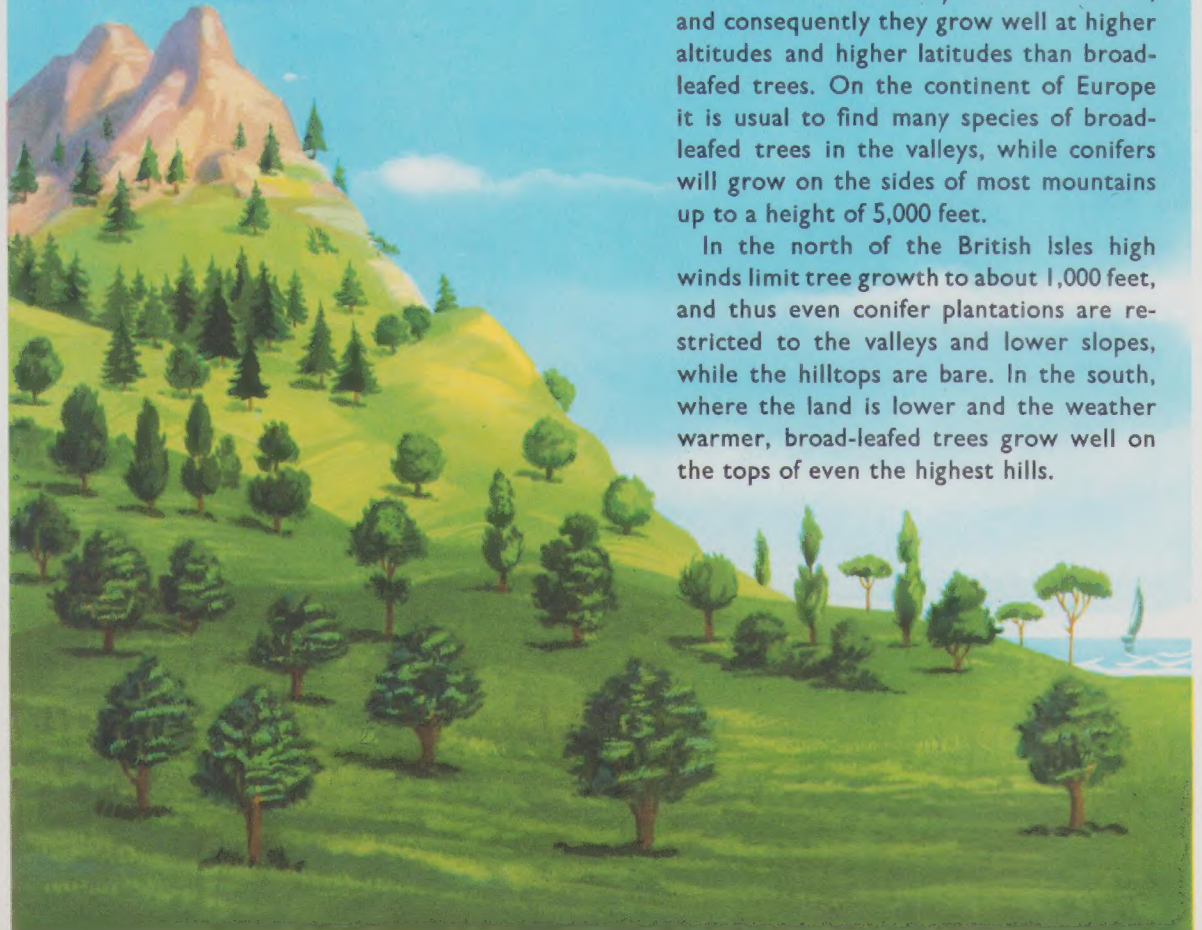
The principal feature which distinguishes the Gymnospermae from the Angiospermae is in the female flowers. In the Gymnospermae the ovules of the female flowers lie exposed on the surface of the carpels, rather than within the carpels like those of the Angiospermae. Consequently, wind-blown pollen from the male flowers may come into direct contact with the ovules and in this way bring about their fertilisation.

After the ovules have been fertilised the carpels close to protect the seed. They increase in size and in hardness to form a cone characteristic of the species of tree on which it is borne. One or (in the cases of some conifers) two years later the cone

THE PARTS OF A TREE



WHERE TREES GROW



Conifers are remarkably resistant to cold, and consequently they grow well at higher altitudes and higher latitudes than broad-leaved trees. On the continent of Europe it is usual to find many species of broad-leaved trees in the valleys, while conifers will grow on the sides of most mountains up to a height of 5,000 feet.

In the north of the British Isles high winds limit tree growth to about 1,000 feet, and thus even conifer plantations are restricted to the valleys and lower slopes, while the hilltops are bare. In the south, where the land is lower and the weather warmer, broad-leaved trees grow well on the tops of even the highest hills.



A Japanese craftsman moulds a clay statue for the tomb of the wife of Emperor Suinin (3rd century A D).

J A P A N E S E A R T

NOBODY knows for certain how men first reached Japan. Thousands of years ago it may have been possible to walk across from the mainland of China, and people probably came from Siberia in the north as well as from Korea in the south. Archaeologists digging in Japan have found the remains of two Neolithic peoples: the Jōmon and the Yayoi. The Yayoi people arrived later, coming in from Korea from about 250 B C onwards, and pushing the Jōmon people out of their way. Eventually the descendants of the Yayoi settled in the province of Yamato, and their rulers called themselves emperors. Ever since then Japan has had an emperor (or empress), even if often they had very little real power.

The early emperors and nobles were buried under huge mounds of earth shaped like keyholes. The biggest of these mounds covers 80 acres, and many workmen must have helped to build it. Often the tombs were surrounded by earthenware models of soldiers or animals – possibly to guard against evil spirits – and inside the tombs models of houses were sometimes placed. All these models are called *haniwa* by the Japanese.

Japan and China

The islands of Japan lie close to the coast of China. It is not surprising, then, that in the past the Japanese have borrowed most of their ideas and techniques from China, both in the arts and in many other fields. In the 7th and 8th centuries A D, particularly, they borrowed as much of Chinese civilisation as they could (see page 478). Nara, the capital of Japan from 710 to 784, was laid out like the Chinese capital; the system of government was Chinese; all the courtiers tried to write Chinese poetry; and Buddhism was encouraged. Strictly speaking,

Clay model (haniwa) of a soldier, from a tomb

Buddhism is an Indian religion, but the early Japanese treated it as part of Chinese civilisation since it had come to Japan from Korea where it had been introduced by the Chinese. The pagoda shown on the right belongs to one of the earliest monasteries founded in Japan, the Hōryūji, which dates from before A D 607. The famous wall-paintings reproduced on the next page come from the main Image Hall of the Hōryūji, and their style can be compared with that of cave-paintings in Afghanistan, India, Central Asia, and China. Unfortunately they were damaged very badly by fire some years ago.

Later periods

In the **Heian** period (974–1185) Japan became much more independent of China, and the court developed a special way of life without parallel anywhere else in the world. Cultured people spent nearly all their time writing refined poems

Five-storey pagoda of the Hōryūji monastery near Nara, built in the 7th century A D





Detail of a Buddhist fresco at the Hōryūji (late 7th century)

to each other, admiring flowers, the moon, and the snow, practising painting and handwriting, and going to elegant parties. Sometimes they had to attend to business, but they preferred beautiful ceremonies they could dress up for. The goddess shown below is wearing the costume of a Heian lady of the court.

Eventually warriors in the provinces, led by two big clans, the Taira and the Minamoto, took control of the country. After a great struggle the Minamoto leader, Yoritomo, defeated the Taira and set up his own government at **Kamakura**, which lasted from 1185 to 1333.

After 1333 there were 250 years of civil war before Japan could be united again; but from 1600 to 1868 the country was ruled by the **Tokugawa** family. For most of the Tokugawa period Japan was a 'closed country' – few foreigners were allowed in, and no Japanese could go out.

Since the end of the feudal regime in 1868 Japan, opened to Western influence, has developed so fast that she is now the most advanced country in Asia.



Painted wooden statue of goddess (late Heian period)

Architecture

Like other forms of Japanese art, architecture owes a great deal to the Chinese. The introduction of Buddhism led to the building of wonderful temples and monasteries, like those of Hōryūji. Some of the wooden buildings there are over 1,300 years old – probably the oldest wooden buildings in the world.

Japanese palaces and houses were generally modest in scale, but in the later 16th century big castles were built, and the great general Hideyoshi built luxurious palaces for himself. In the Tokugawa period the style of ordinary Japanese houses was perfected. They are built of wood, with sliding doors and shutters looking on to a carefully designed garden; the rooms are floored with matting, and there is hardly any furniture. The general effect is airy, elegant, and simple.

Yoritomo, the great general (detail of portrait, Kamakura period)



Japanese painting

Many Japanese paintings are Chinese in style, though with practice it is not usually difficult to tell them apart. Like the Chinese (see page 2939), the Japanese used a brush on silk or paper; most paintings are in water colour and many simply in black ink. Some of the finest paintings are on screens, often with a gold or silver ground.

Some of the most attractive paintings are in a purely Japanese style. In the Heian and Kamakura periods there were many painted hand scrolls which were unrolled in the same manner as those of the Chinese. One famous set of scrolls light-heartedly shows birds and animals acting like human beings.

The two main schools of Japanese painting were the Tosa (dating from about 1400), specialising in illustrations of Japanese themes, and the Kanō (founded in the 15th century), the paintings of which were more influenced by Chinese art. The Kanō became the official school, and their rather academic style dominated Japanese painting for centuries. Its most famous early exponent was Motonobu (1476–1559), who was the son of the school's founder.

In the Tokugawa period there were many different schools. Ike no Taiga (1723–1776), for example, belonged to the Literary Men's school, which took its ideas from China: but the way in which Taiga uses his brush is thoroughly Japanese. The quiet style of the Literary painters is in some ways reminiscent of English water-colour paintings. The Maruyama and Shijō schools were also inspired by China, but their brushwork is rather stronger.

Some artists, particularly those of the Ukiyoe or 'floating world' school of painting founded in the 17th century, were influenced by European types of perspective drawing.





Part of a long hand scroll showing animals playing together (Kamakura period)



Painting by Ike no Taiga (1723–1776) showing a thatched cottage standing by rice fields

Japanese prints

The Ukiyoe school is most famous for its colour prints. Printing has been known in China and Japan far longer than in Europe, but before the 17th century most printed pictures were religious. Thousands of prints from the Tokugawa period, however, show topical scenes, including many portraits of actors and fashionable beauties, scenes from the theatre, landscapes, and pictures of plants and animals.

The prints were made from wood-blocks. Until the mid-18th century popular woodcuts were generally uncoloured, or at most coloured

◀ 18th-century print of a girl at an entertainment house



LACQUER

Lacquer is an important art in Japan, so much so that the old English name for lacquer was japan. For everyday use the Japanese preferred plates and dishes made of lacquer, which is light and hard-wearing and able to withstand great heat and, unlike porcelain, does not break easily.

The oldest Japanese lacquer was made 1,200 years ago. Beautiful work was done in the Heian period, when lacquer was used to decorate important buildings as well as for ornaments.

In the Kamakura era methods of inlaying lacquer with precious metals and shells were improved. In the 15th century gold Japanese lacquer was so admired that Chinese workmen came to Japan to learn the technique. In contrast to this gold lacquer was the plain black ware used by the Zen Buddhists of the same century, which had little or no decoration.



Lacquer plate, decorated with flowers and a dragonfly (late 16th century)

There are many ways of making and decorating lacquer, which is prepared from the sap of the lacquer tree. Usually the lacquer is built up over a very thin base, generally of wood but sometimes of materials like hemp, earthenware, or paper. A great number of coats are applied – the preliminary work alone for artistic lacquer work can take over 18 days. Lacquer can take on an extremely high polish, and among substances used to decorate it are gold and silver (inlaid or painted on), shells, and amber.

Lacquered box made by Ogata Kōrin (1658–1716), one of the greatest artists of his time



only by hand; but in the 1740s prints using two colour blocks were produced for general sale. From 1765 woodcuts were often beautifully printed in many colours.

Nature and art in Japan

Japan is a beautiful country of mountains, mists, forests, and waterfalls, and Japanese artists have been much influenced by the landscape around them. When they are not trying to imitate Chinese or European art they show their great love for nature and landscape, and they have a wonderful feeling for good, simple design.

Today some of the world's best architects are Japanese, and Japanese houses, ink painting, prints, and pottery have inspired many modern European architects, artists, and designers.

BERKSHIRE, WILTSHIRE, AND DORSET



Windsor Castle, the famous royal residence in Berkshire

WEST and south of London lie a series of chalk downs, linked to the Chiltern Hills north of the Thames and running south to the sea in Dorset. They curve through the counties of Berkshire, Wiltshire, and Dorset, and as a result these three have much in common, both in the type of countryside, the activities of the people who live there, and in their early history.

These easily drained hills provided just the sort of surroundings that prehistoric men liked and were among the most densely populated parts of Britain in early times. As a result the hills of all three counties have many prehistoric remains, including long barrows and round barrows (see page 1477), and hill forts. Maiden Castle in Dorset, with its great triple ramparts of earth, was a Stone Age

fort long before the great earthworks we see today were constructed. Wiltshire is famous for Stonehenge (see page 513), and in the north is another prehistoric collection of stones at Avebury, which many people think is even more interesting and impressive. Quite near Avebury is Silbury Hill, the largest man-made mound in Europe. It was certainly in existence before the coming of the Romans, since the road they built to Bath swings round it; but extensive excavations have failed to show what it was built for. Across the top of the downs from Oxfordshire through Buckinghamshire and Berkshire and into Wiltshire runs the Ridgeway, one of the great prehistoric routes. Berkshire, too, has many hill forts, including that on Sinodun Hill. When the Romans came they drove great roads through the counties, building towns at – among other places – Mildenhall, Old Sarum, Newbury, and Dorchester. More interesting, however, are the Saxons – for this was the battlefield of Alfred the Great.

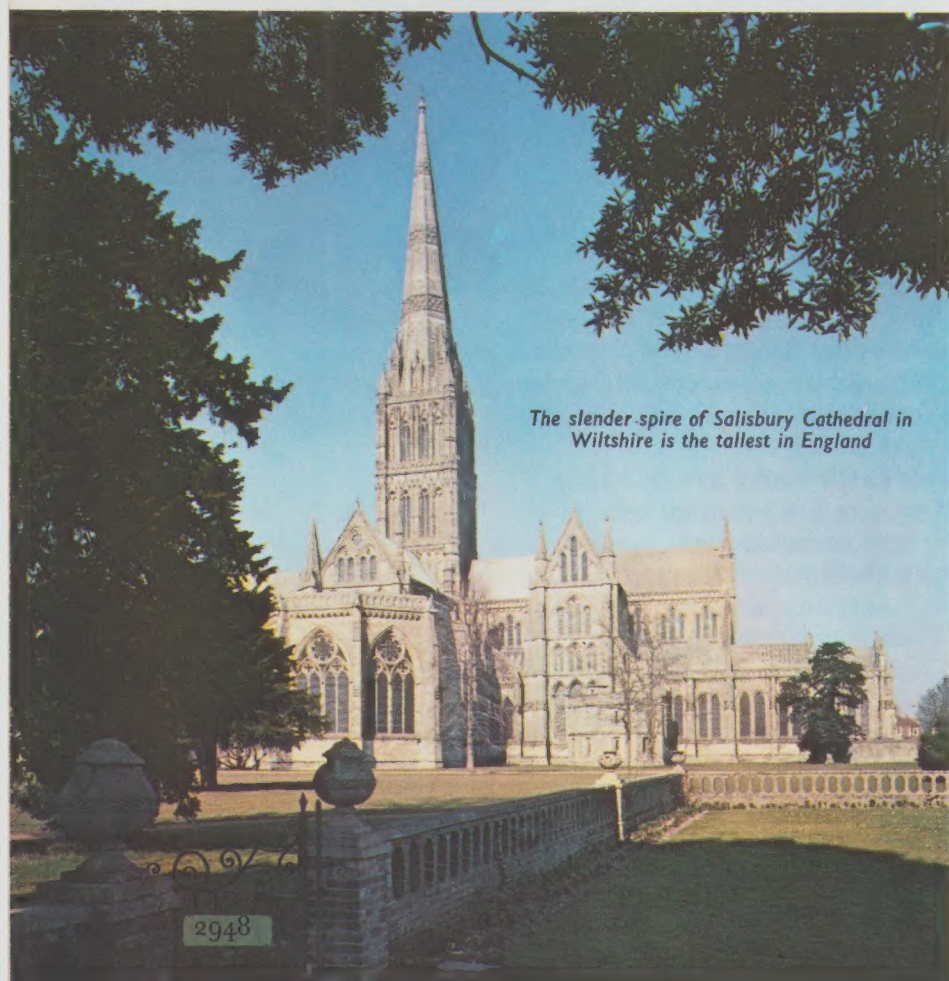
KING ALFRED'S COUNTRY

Alfred was born at Wantage, in the north of Berkshire, in A D 849, and the White Horse cut into the chalk downs a few miles away was, according to tradition, put there to celebrate his victory over the Danes at Ashdown. King Alfred's name occurs frequently in all three counties, which came into the Saxon Kingdom of Wessex. He is thought to have been educated at Sherborne School, in Dorset, which was founded in the 8th century, and he defeated the Danes in a naval battle off Swanage. Among his Wiltshire battles were those at Marton and Wilton.

In the Middle Ages the chalk downs were grazed by sheep whose wool and industries associated with it brought the local towns prosperity. Reading and Newbury, Berkshire's chief towns, were both flourishing centres of the cloth trade; Salisbury's prosperity in the Middle Ages was based on wool; and Trowbridge and Bradford-on-Avon, in the west of Wiltshire, grew rich through the fine-quality cloth woven there. Dorset's wool was not especially esteemed in the Middle Ages, and its most famous product at that time was Purbeck marble, found in the east of the county. Thousands of tons left the county in the 12th and 13th centuries; in 1239 four shiploads were sent to the Tower of London, and it was also used in Salisbury Cathedral, Canterbury Cathedral, and Windsor Castle among many other places.

17th-CENTURY STRIFE

The counties were intensively fought over in the Civil War. Newbury saw two important battles, in 1643 and 1644; Wiltshire as a whole supported Parliament, although the Royalists defeated the Parliamentarians at Roundway Down in 1643, and a rising on behalf



The slender spire of Salisbury Cathedral in Wiltshire is the tallest in England

Cattle graze near Cranborne Chase – a scene typical of these three predominantly rural counties



of the King at Salisbury was dispersed in 1655. The most famous incident in Dorset at this time was the siege of Corfe Castle, when Lady Bankes, a widow, held the castle for six weeks before the Parliamentary forces captured it through treachery. The commander of the Roundheads was so impressed by her courage that he saved the lives of 140 of her garrison.

Since the Civil War these counties have been at peace. The Industrial Revolution, which changed many parts of England, had little effect on them as they were without the coal to provide power for large factories. The building of the Great Western Railway in the 19th century led to the growth of towns like Reading, Chippenham, and in particular Swindon, near which the main engineering works of the railway were built. But on the whole Berkshire, Wiltshire, and Dorset are still agricultural counties with few large towns.

A LITTLE GEOGRAPHY

The chalk downs which rise up from the Thames at Streatley in Berkshire are, in fact, a continuation of the Chiltern Hills to the north of the Thames. The whole chain of downs is linked together – the Berkshire Downs merge into the Marlborough Downs in Wiltshire, which are separated from Salisbury Plain by the Vale of Pewsey; Salisbury Plain runs over into Dorset at Cranborne Chase, and drops down to the Stour Valley, from the other side of which rise the North Dorset Downs. These, in their turn, are linked to the South Dorset Downs which run along the coast.

Many of the valleys between the downs contain clay soil which is fertile and provides good grazing for dairy cattle, and there are also areas of heath like those around Sandhurst and Ascot in Berkshire and the great heaths of east Dorset. Much of the land was once forested, and the remains of these woods are seen in Windsor Forest, Savernake Forest near Marlborough, and the woods of Cranborne Chase.

WHAT THE PEOPLE DO

All three counties are predominantly agricultural. Sheep, dairy cattle, and pigs are reared, and crops including wheat, oats, barley, and root crops are grown. North Berkshire is famous for its soft fruit, particularly cherries.

Most local industries have grown up around local products. Carpets are made at Wilton (a reminder of the wool trade); milk is processed at several places, including Chippenham, Melksham, and Trowbridge; and Calne is famous for its bacon and sausages. One of the largest cheese factories in the world is at Bailey's Gate in east Dorset. In some places the making of agricultural machinery has led to the growth of engineering.

Stone is quarried in Wiltshire and Dorset; Bath stone, from quarries at Box and Corsham, is well known, and Portland stone from the Isle of Portland on the Dorset coast is one of the most widely

used building stones. Dorset also has cement and brickworks, and pottery is made at Poole, the largest town in the county.

Berkshire is the most industrialised county of the three, partly because it is close to London. There are various light industries in the east of the county; biscuits are exported all over the world from Reading, which also has an important seed-producing industry. Paper and board are manufactured at Colthrop, and the Oxford car industry has overflowed to Abingdon and Theale. Berkshire also has two of the main nuclear research stations in Britain: the Atomic Weapons Research Establishment at Aldermaston, and the Atomic Energy Research Establishment at Harwell where the peaceful uses of atomic energy are investigated.

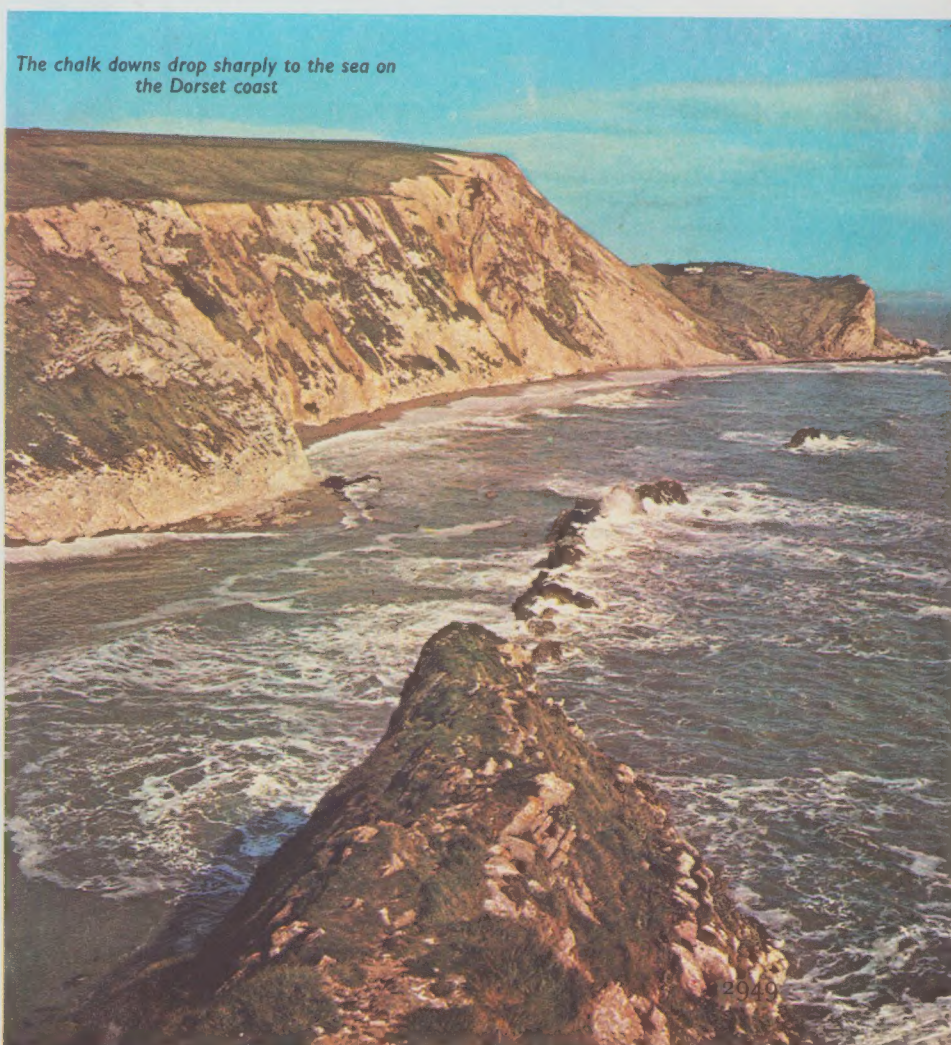
Yet another activity of these counties is military training. Sandhurst, in Berkshire, is the home of the Royal Military Academy, and Salisbury Plain is one of the Army's greatest training grounds. The first Air Force training school was set up at Netheravon, and Upavon is now the headquarters of Royal Air Force Transport Command.

ARCHITECTURE AND SCENERY

It is impossible to write about these three counties without mentioning some of their outstanding buildings which rival any in Britain; it is almost as impossible to choose which of them to mention. Windsor Castle has already been described on page 278, and Longleat, the magnificent seat of the Marquess of Bath in south Wiltshire, is mentioned on page 1602. Sherborne Abbey, founded by St Aldhelm in the early 8th century, is built of golden stone and is famous for its perpendicular fan-vaulting, and Salisbury Cathedral has the highest and possibly the loveliest spire in England. Wilton House, near Salisbury, Coleshill House in Berkshire, Lacock Abbey in north Wiltshire – all, and many more, would be well worth describing if there were room. And in so short an article it is not possible to describe the varied and lovely scenery. But if you live in London most of Berkshire is within easy reach, and for a description of Dorset and Wiltshire you cannot do better than read the novels of Thomas Hardy, who was born near Dorchester in 1840 and wrote vividly descriptive novels about the country he knew and loved so well.



Map of Berkshire, Wiltshire, and Dorset



The chalk downs drop sharply to the sea on the Dorset coast

DICOTYLEDONOUS PLANTS



Tulip (a monocotyledon)



Cyclamen (a dicotyledon)

YOU probably know the names of the two beautiful flowers shown above. But do you know which of the two great Classes of flowering plants or Angiospermae they each belong to? If you have read our article on monocotyledonous plants (page 2887) you should know that the tulip is a monocotyledon and the cyclamen a dicotyledon.

The table below sums up the main characteristics of the two Classes of Angiospermae.

MONOCOTYLEDONEAE	DICOTYLEDONEAE
Leaves with parallel veins	Veins forming a network
Flowers with three or a multiple of three petals	Two or five petals or a multiple of two or five
Roots forming a tuft	Usually a tap root
Seed with one cotyledon	Seed with two cotyledons

Forty-four Orders

The dicotyledons are far more numerous and diversified than the monocotyledons. They are divided into 44 Orders; the monocotyledons into only 10. Among the 'dicots' (as botanists often call them for convenience) there is a far higher proportion of woody plants; with the exception of the palms almost all flowering trees and bushes are dicots, and so are all timber-producing trees (other than conifers, which are not flowering plants). One very important group of food-producing plants – the cereals and grasses – consists of monocots, but most of the others are dicots. In our two articles on plants in industry (pages 2246 and 2270) 15 kinds of dicotyledon but only four kinds of monocotyledon are mentioned.

GAMOPETALOUS FLOWERS

The petals of these flowers are joined either at the base (primrose) or throughout their length (potato) to form a tube or cup. The term *gamopetalous* (or *sympetalous*, which means the same thing) is a descriptive one, and not a category used in classification. This means that different sorts of plants which have flowers of this kind are not necessarily related to one another.

ORDER PRIMULEALES

Family: Primulaceae
cyclamen
primrose



Leaf and flower of primrose

ORDER ERICALES

Family: Ericaceae
heather
rhododendron
myrtle



Mediterranean heath



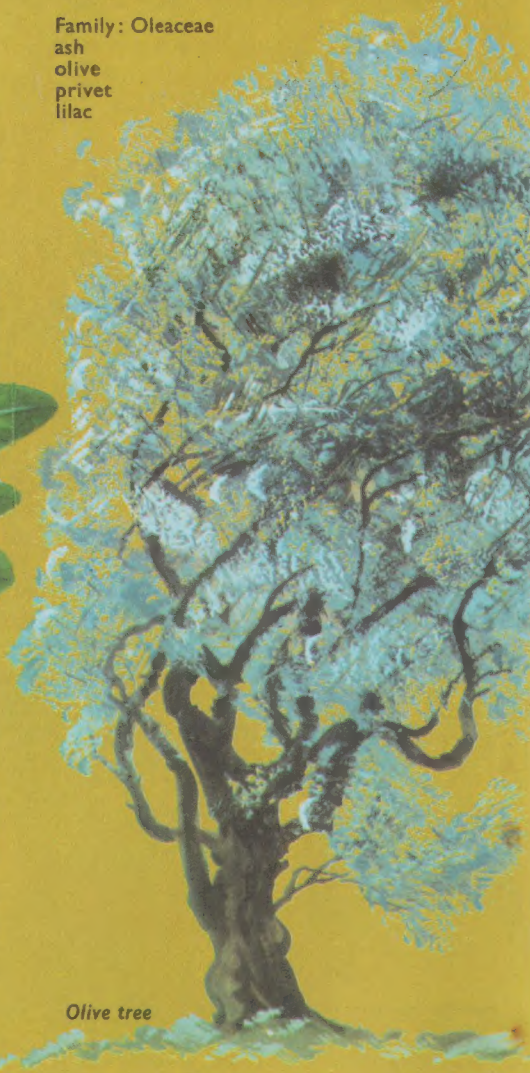
Rhododendron flowers



Myrtle

ORDER LIGUSTRALES

Family: Oleaceae
ash
olive
privet
lilac



Olive tree

ORDER TUBIFLORAE

Family: Solanaceae
potato
tomato
nightshade



Potato flower

Family: Labiatae
mint
thyme
sage
lavender



A kind of sage
(*Salvia splendens*)

Family: Acanthaceae
acanthus



Leaves and in-
florescence of
acanthus

ORDER RUBIALES

Family: Rubiaceae

gardenia
coffee



Double-flower-
ed gardenia

ORDER CAMPANULATAE

Family: Compositae
cornflower
artichoke

daisy
aster
dahlia
dandelion

thistle
groundsel
sunflower
lettuce



Cornflower

Inflorescence of artichoke

Dahlia

ORDER CUCURBITALES

Family: Cucurbitaceae
vegetable marrow
cucumber
white bryony



Female flower of vegetable marrow

POLYPETALOUS FLOWERS

The petals of these flowers are not joined but are quite free from one another. The petals may be all alike, like those of the buttercup, or of different shapes in the same flower as in the pea.

ORDER RANALES

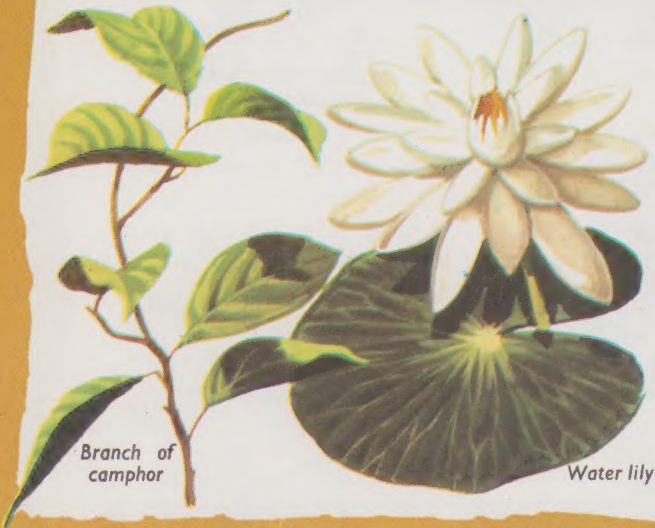
Family: Ranunculaceae
anemone
buttercup
celandine
anemone



Anemone fulgens

Family: Lauraceae
camphor
laurel

Family: Nymphaeaceae
water lily



Branch of
camphor

Water lily

ORDER RHOEDALES

Family: Cruciferae
cabbage
wallflower

Family: Papaveraceae
poppy



Flower of
cabbage



Poppy

ORDER THEALES

Family: Theaceae
camellia



Double-flower-
ed camellia

ORDER PARIETALES

Family: Violaceae
violet
pansy

Family: Droseraceae
sundew
venus's fly-trap



Mountain pansy



Sundew

ORDER ROSALES

Family: Rosaceae
rose
pear
hawthorn
almond
apple
bramble



Almond flower

APETALOUS FLOWERS

These are flowers which have no petals (*corolla*), and in which the sepals (*calyx*) may also be absent. Many plants with apetalous flowers are wind-pollinated.

ORDER FAGALES

Family: Fagaceae
oak
beech
sweet chestnut

Family: Betulaceae
birch
alder



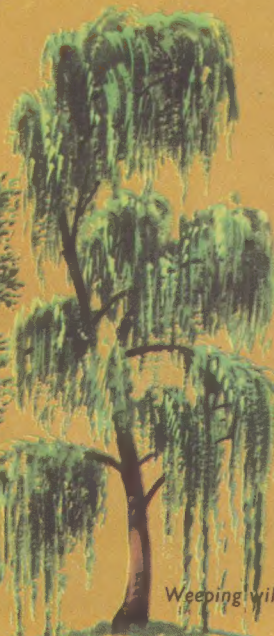
Oak tree



Birch trees



Walnut tree



Weeping willow

ORDER JUGLANDALES

Family: Juglandaceae
walnut
hickory

ORDER SALICALES

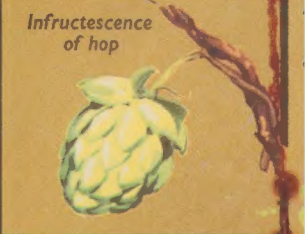
Family: Salicaceae
willow
poplar

ORDER URTICALES

Family: Urticaceae
nettle



Family: Cannabinaceae
hemp
hop



ORDER MALVALES

Family: Malvaceae
mallow
cotton



Flower of mallow

Family: Bombacaceae
baobab
ceiba



A gigantic
baobab tree

ORDER LINALES

Family: Linaceae
flax



An ornamental
flax (Linum
grandiflorum)

ORDER RUTALES

Family: Rutaceae
rue
orange



Flowers of
common rue

Family: Papilionaceae or
Leguminosae



Inflorescence of
wisteria

wisteria
laburnum
pea
bean
vetch
clover
broom
gorse

ORDER MYRTALES

Family: Myrtaceae
myrtle
eucalyptus



Branch of
myrtle

ORDER RHAMNALES

Family: Vitaceae
vine



Bunch of grapes

ORDER UMBELLIFLORAE

Family: Umbelliferae
carrot
celery
hemlock



Carrot plant

ORDER URTICALES

Family: Moraceae
mulberry
fig



Mulberry
tree

ORDER OPUNTIALES

Family: Cactaceae
prickly pear
cactus



Giant cactus
(Cereus gi-
ganteus)

ORDER CHENOPODIALES

Family: Chenopodiaceae
beet



Forage beet

ORDER EUPHORBIALES

Family: Euphorbiaceae
castor oil
para rubber



Fruit of castor
oil plant

ORDER HAMAMELIDALES

Family: Platanaceae
plane



A plane tree



The famous Mont-Saint-Michel at low or ebb tide (left) and at high or flood tide (right)

TIDES

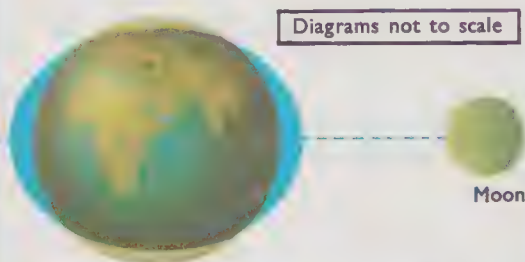
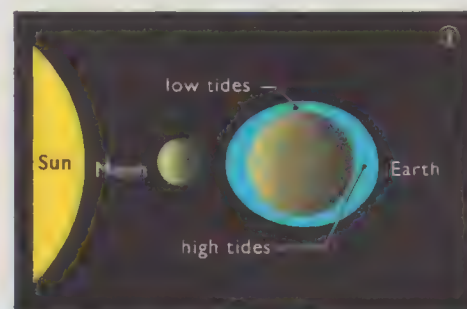
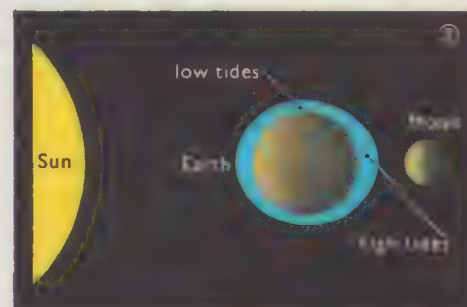
TWICE every day Mont-Saint-Michel, the famous monastery built on a rock on the north-west coast of France, becomes an island. The land surrounding the cone-shaped rock becomes entirely covered by the sea, and access to the monastery is limited to the narrow causeway shown on the left of the pictures above. This curious phenomenon is, of course, explained by tides—the rhythmic ebb and flow of the sea which is familiar to anyone who has spent a holiday at the seaside. But what are tides? What causes them and related phenomena such as whirlpools which are created when two opposing tidal currents meet?

Tides are the movement of the ocean waters in response to the gravitational pulls of the Earth, Moon, and Sun, and their size and duration are affected by the varying relationships between these pulls. Although the Sun is heavier, the Moon's tidal influence is greater because it is much nearer the Earth. The Moon rises approximately 50 minutes later each day, and so, too, the times at which the tide comes in advance by 50 minutes every day. As the Earth itself rotates every 24 hours, any point on it looks towards the Moon and away from it once every 24 hours 50 minutes. The Moon's high-tide-producing forces act both when the Earth is facing towards and away from the Moon, so the interval between high tides is generally 12 hours 25 minutes.

TIDE VARIATIONS

The story of the tides is complicated by the fact that the influence of the Sun and Moon varies with the phases of the Moon, the distances of the Moon and Sun from different parts of the Earth, and the position of each north or south of the Equator. If you look at the diagrams on the right you will see that when the positions of the Sun and Moon are at right angles to each other in relation to the Earth (diagram 1), as at half Moon, their tide-raising effects act in opposition and *neap* tides occur (the lowest high tides and the highest low tides). But when the Sun and Moon are diametrically opposed to one another (diagram 2) at full Moon, or when they are both on the same side of the Earth (diagram 3) at new Moon, their tide-generating effects are complementary and *spring* tides occur (the highest high tides and the lowest low tides). Spring tides have a *range* (the difference in level between successive high and low waters) three times greater than that of neap tides.

Neap tides occur when the positions of the Sun, Earth, and Moon are at right angles to one another; *spring* tides occur when they form a straight line



Diagrams not to scale

High tides occur at that part of the Earth which is facing directly towards or away from the Moon

TIDAL BASINS

Scientists believe that the oceans contain a number of tidal *basins*, and, although the movement of the waters within each of these basins is originally set in motion by the Moon and the Sun, the time between two high tides is also influenced by the physical dimensions of the basins. The swing of the water within the basins has a see-saw motion. Places near the centre of the see-saw experience little movement, while places at the ends experience the full range. This helps to explain the curious situation which is found off the east coast of North America. At Nantucket Island, 25 miles south of Cape Cod, Massachusetts, the tidal range is only about 1 foot, while in the Bay of Fundy, a few hundred miles farther north, it varies from 40 to 50 feet.

TIDAL RHYTHM

The rhythm of the tides also varies. In some places there are two high or flood tides and two ebb or low tides every day, while at others (because of the shape of the tidal basin) there is just one high tide and a succeeding low. Around the shores of the Atlantic the normal tidal rhythm is two high tides and two low every day, but at certain places – on the Gulf of Mexico, for example – there is a single ebb and flood. In the Pacific Ocean both of these tidal rhythms occur, but at the Pacific island of Tahiti a strange thing happens. Contrary to the general rule, the Moon does not seem to influence the rhythm of the tides around Tahiti at all. Instead of advancing by 50 minutes every day, high tide occurs regularly at midnight and at noon. Apparently this island lies at the axis of one of the tidal basins – at the midpoint of the see-saw. Since this is the point where there is least response to the Moon, the Sun takes over and the waters adapt their rhythm to it.

TIDAL BORES

Tides are responsible for the creation of many unusual phenomena, one of the most famous being the tidal *bore* – a mass of tidal water which enters a river mouth as a single wave, or as two or three waves at the most, with a steep, high front. Tidal bores can only form in rivers with sandbars at their mouths and along coasts with a considerable tidal range. The sandbars keep the mass of water back until it has accumulated sufficient force to rush over the barrier and sweep up the river, sometimes for hundreds of miles. The Amazon, for example, has a tidal bore that travels several hundred miles inland and is some-

Materials deposited at high tide sometimes cause rivers to silt up like the one shown here on the coast of Georgia in the United States

times over 15 feet high. The most famous tidal bore in Britain is the one which sweeps up the river Severn, sometimes as far as Tewkesbury, at a height of 3 or 4 feet.

STRANGE EFFECTS

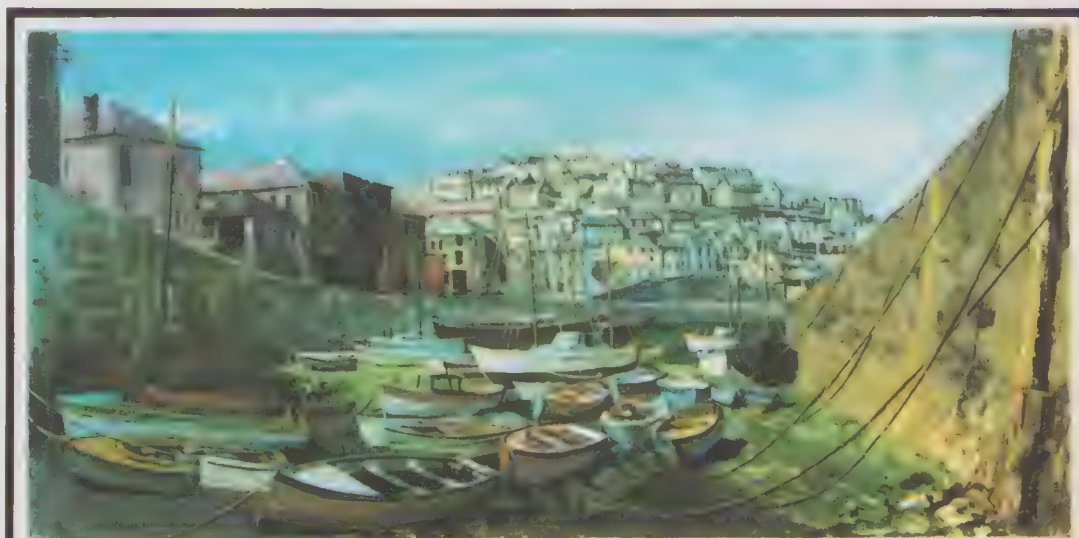
One of the strangest and most fascinating responses of living creatures to the movement of the tides is that of the palolo worm which lives in crevices and holes of the coral near Samoa in the Pacific. During the October and November neap tides this worm breaks itself in half. One half remains in its coral home while the other half floats to the surface of the ocean where it sets free its reproductive cells. This occurs exactly at dawn on the day before the Moon reaches its last quarter and again on the following day. In other parts of the Pacific palolo worms are found following a similar pattern of behaviour. But in some places they respond to the new Moon, in others to the full Moon, and in others to a mixture of both.

As time goes on, the Moon is moving very gradually farther away from the Earth, and it is taking it longer to complete each revolution around the Earth. Its power over the oceans is, therefore, very slowly declining. On the other hand, the movement of the waters over the ocean beds is creating friction which retards the rotation of the Earth about its own axis. At some very remote future date it is possible that this will mean there will be no further tides caused by the Moon. But until that time we shall continue to marvel at bores and whirlpools and the other strange phenomena associated with tides.



DID YOU KNOW?

1. The mean spring tidal range in the middle of the Mediterranean is approximately 1 foot; at Trieste, on the Adriatic coast of Italy, it is approximately $2\frac{1}{2}$ feet; at Granville, on the north-west coast of France, approximately 38 feet; at Puerto Montt, on the coast of Chile, approximately 20 feet; at Burntcoat Head, in the Bay of Fundy, Nova Scotia, Canada, approximately 48 feet; and at Cape Horn, the southern tip of South America, approximately 8 feet.
2. The effects of the ebb and flow of the tides extend inland on the river Amazon for over 500 miles; on the river Seine for 96 miles; and on the river Thames for $62\frac{1}{2}$ miles.



Fishing boats stranded at low tide in the harbour of a Cornish fishing village



*A 'soldier' of the
Termes bellicosus,
enlarged five times*

TERMITES

WHAT THEY LOOK LIKE

Most termites are pale-coloured, soft-bodied insects, only the head and jaws being hard and usually reddish-brown. The fertile males and females that periodically swarm out of the nest have two pairs of delicate gauzy wings. The soldiers, which defend the nest, have large heads and powerful jaws.



IN the early days of European settlement in Australia a man returned to his home after an absence of about a week. He opened the door and sat down on a chair – and it collapsed under him as if it were made of paper. As he fell he clutched at the table, and it crumbled into a heap of splinters and dust. Staggering across the room, he collided with the door-post, which buckled and broke, bringing the whole house down about his ears, almost burying him. This sounds rather like a scene from a funny film, but it is a true story, told by the Belgian writer Maurice Maeterlinck to illustrate the extraordinary powers of destruction possessed by the feeble-looking little insects called termites.

The termites' nest

In some tropical regions, especially in Africa and Australia, the nests of termites are a conspicuous feature of the landscape. The largest are tall, steeple-like structures up to 20 feet high and 50 feet around the base. Some Australian nests of this type are flattened, with the broader sides always facing east and west, and the makers are known as 'compass termites'. Other nests are built in trees, but many kinds of termites nest entirely underground. The building material is earth or rotten wood or, quite frequently, the insects' own excrement. The big above-ground nests are built of a kind of cement made of saliva and clay which sets extremely hard. Inside, the nest consists of a system of tunnels and chambers, the largest of which are inhabited by king and queen. The temperature and humidity are kept constant and rather high, and there are no permanent openings. If a column of workers leaves the nest at night to forage for food, they close up the exit holes as soon as they return. Termites live and thrive in what we should regard as a perpetual fag.

WHAT ARE TERMITES?

Termites are often called 'white ants'. It is true that they look rather like ants and live in a similar way in huge communities, but they are not just a special kind of ant; they are not ants at all. Ants are allied to bees and wasps, and with them belong to the insect Order Hymenoptera. The termites form an Order of their own, the Isoptera; their nearest relatives among the other insects are cockroaches. The life-history of a termite shows that it is an entirely different type of insect from an ant, for it does not pass through larva and pupa stages as ants do (page 1879). When a termite hatches from the egg it is like an adult in most respects except size. It grows, as all insects do, by successive skin-changes, but undergoes no important change of form, except that it may grow two pairs of long gauzy wings.

SOCIAL ORGANISATION

Termites, like ants, are social insects; that is, they live in communities. All social insects have a 'caste' system, whereby the work of the community is done by numerous sterile individuals and reproduction is confined to one or a few 'queens'. In an ants' or bees' nest all the workers are females, and the queen mates once and never sees her husband again. In a termites' nest the king and queen live together, and the workers are sterile males and females.



Some examples of the strange shapes of termites' nests: ① an extremely tall, steeple-shaped nest; ② a nest shaped rather like a mushroom; ③ one built on a dead tree-trunk; ④ a nest of irregular shape

WHERE THEY LIVE

Termites are mainly tropical insects, and are found in Africa, Asia, America, and Australia. One or two species live in southern Europe, but there are none in Britain. It is a fact worth noting that the termites or Isoptera are the only insect Order that is not represented in this country.





HOW THEY FEED

Termites are exclusively vegetable feeders, and many kinds live entirely on wood, usually dead wood; it is this, of course, that makes them so destructive. These wood-eating insects seldom or never venture into the open. If they live underground, they simply burrow to the underneath of a fallen tree or the foot of a post and eat their way into it. Those that seek their food above ground often build little covered galleries which run over the ground away from the nest, like roads leaving a city. Some cultivate fungi for food in their underground nests, just as certain ants do.

When the queen termite left the nest where she was born, together with hundreds of other fertile males and females, she was little larger than the workers. With her husband she founded a nest peopled entirely by her own children. Now, her body fantastically swollen, she lives in the royal chamber with the 'king' (who is much smaller), and both are fed by the workers on their saliva. A queen termite may live for more than 20 years and will sometimes lay several thousand eggs a day.



The jaws of the soldier termites are adapted for fighting; they cannot feed themselves, but depend on the workers, who give them saliva from their mouths.



Termites and ants are perpetually at war; the ants are the aggressors and eat any termites they can kill. Some soldier termites are equipped with strong jaws to fight the ants, while the heads of others are formed like a snout and squirt a sticky liquid over their enemies which completely disables them.

UNINVITED GUESTS

The termites' nest nearly always has other inhabitants besides the termites that made it. Many of these are insects—for example, the curious wingless fly, *Termitoxenia*, which is illustrated on the right. There is another kind of fly, *Termitometopia*, whose maggots or larvae live in termites' nests in South Africa. The curious thing in this case is that the worker termites feed these maggots from their mouths, just as they feed the king and queen and soldiers of their own community; they treat them, in fact, as pets. Both ants and termites have pampered guests or pets of this kind in their nests, and in many cases it has been shown that they provide a liquid substance which the termites or ants eagerly lick up.

Several different kinds of reptiles are found living in termites' nests or burrowing under them. These include geckos, the legless lizard *Amphisbaena*, and the snake *Typhlops*.



GEORGE III

'GEORGE, be a king!' whispered the mother of the future George III. Her son took her advice. He set about exercising his constitutional rights to the full, choosing and dismissing his ministers as he wanted and becoming virtually his own Prime Minister. But George's kingship had unfortunate results. Not only is his reign remembered as one full of follies and failures, but in 1780 the House of Commons passed a memorable and humiliating resolution: 'That the king's power has increased, is increasing, and ought to be diminished.'

On his accession to the throne at the death of George II in 1760 George III determined to crush the great Whig families who had dominated politics since the beginning of the Hanoverian era in 1714. His first victim was William Pitt – a non-party man who might have seemed a natural ally for George with his aversion for organised parties. But Pitt was too powerful – while he was gloriously conducting the Seven Years War George had little chance of controlling the government or of promoting his favourite, the unpopular Scotsman Lord Bute. So George encouraged Pitt's enemies. He denounced the war as bloody and expensive and triumphed when, in 1761, the 'great commoner' resigned over the question of war with Spain. A few months later George achieved an even greater victory with the resignation of the Duke of Newcastle, controller of patronage, distributor of bribes and sinecures, and organiser of Whig majorities. George now took over the whole policy of patronage himself and was in a position to organise his own 'party' and majorities in the Commons.

George used his new power to the full. Bute succeeded Newcastle at the Treasury, and by energetic bribery a large majority of 'king's friends' was obtained in the Commons. The Seven Years War was concluded in 1763 (on terms which Pitt thought disgraceful), and for the next 20 years George was able to summon and dismiss his ministries almost as he liked.

These manoeuvres did not go uncriticised. In the famous 'No. 45' of the *North Briton* (April 1763) John Wilkes expressed the discontent aroused by the dismissal of Pitt and the retention of Bute. For the next seven years George carried on a relentless persecution of Wilkes, excluding him from Parliament, refusing him rights to publish, and punishing him in other ways.

Although George could pick and choose his ministers, it took him some time to find a man who was fully acceptable. Bute proved too weak and had to go in 1763. He was replaced by George Grenville

who in turn gave way to Lord Rockingham. In 1766 George at last reinstated Pitt, and perhaps Pitt's ministry – drawn from all parties – might have proved acceptable to the king as well as administratively efficient. But, unfortunately, Pitt's mind gave way, and in 1770 George at last found a man who would take his orders directly and obediently from the king – Lord North. For the next 12 years the government of the country was, in most essentials, the result of the personal policy of the king. The Prime Minister – a pliant, timid man – became a mere organ through which the king spoke.

END OF GEORGE'S PERSONAL RULE

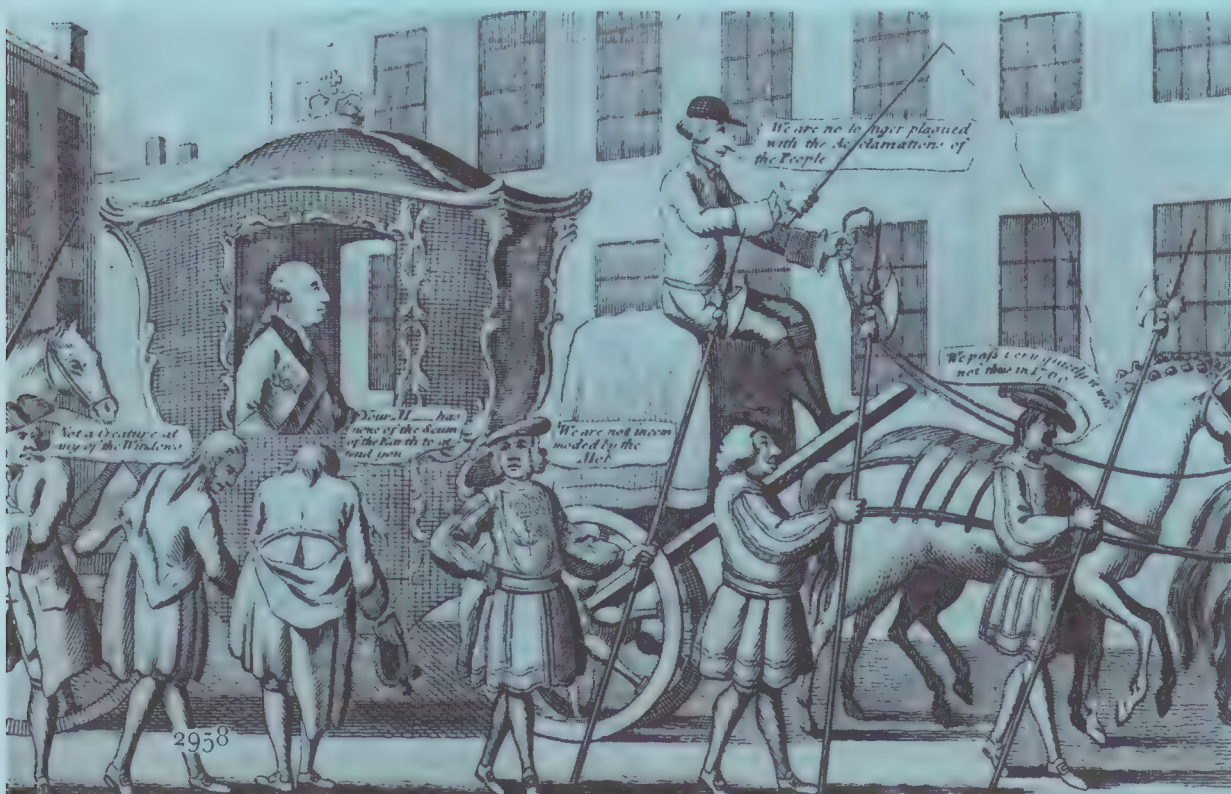
George's 'personal rule' was ruined by the disasters of the American War of Independence (1775–1783). He had always taken the view that the colonies should pay for the benefits, as he saw it, they received from Britain. He had been largely responsible for the legislation which antagonised the colonies in the years before the war. First came the Stamp Act (1765), then the Townshend Acts (1767), and the Tea Act which led to the Boston Tea Party (see page 545). In 1775 a war began in which George himself took complete responsibility and supervised almost every detail of its conduct. It proved a terrible failure. Criticism of the king grew. People discovered that the king was spending vast sums of public money on bribes for his placemen. In 1780 the Commons passed its momentous resolution against the encroachments of the king. When it became clear that the American colonies were lost George contemplated abdication. In the face of military defeat the majority of 'king's friends' in the Commons disappeared, and once again George had to accept a Whig ministry. In 1783 he had to put up with the detested Fox-North coalition, but finally succeeded in appointing the younger William Pitt (see page 2400) as Prime Minister at the end of that year.

The year 1783 marks a clear turning point in George's reign and in British constitutional history. From then on his influence declined rapidly. It is true that he was still politically important. After all, he was largely responsible for Pitt's victory at the polls in 1784, and he did make Pitt promise not to raise the question of Catholic Emancipation before parliament. But Pitt's 17-year premiership banded his cabinet together in allegiance to their Prime Minister rather than to the sovereign. This allegiance was the real beginning of cabinet government and the principle of corporate responsibility, and it was permanently to undermine royal authority.

Another reason for the king's declining authority was, of course, his increasing insanity. Symptoms had been noticed as early as 1765, but after 1788 they became more frequent and serious. In 1811 he became permanently mad. His son, the future George IV, became regent until the old king died, blind as well as mad, on 29th January 1820.

Oddly enough, George III, so unpopular in his early days, spent his last years in almost unprecedented popular esteem. This was largely because of the general hatred of his son, whose dissipated living contrasted strongly with George III's homely, domestic virtues. Then, too, as he became less powerful it was easier to see his merits when his faults were not being criticised. His staunch conservatism endeared him to many, while his interest in agriculture (he was known as 'Farmer George') did much for farming. And no king has shown greater moral courage than George III, the king who sought to govern the British Empire by himself.

A Punch cartoon of 1770. No cheering crowds line the streets to welcome their unpopular king

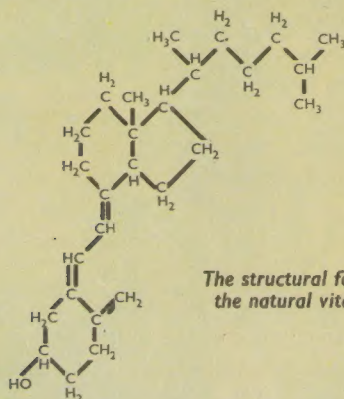


A stylized illustration of four young boys sitting in a room. They are all wearing white swim trunks and dark sunglasses. They are seated on simple wooden chairs. The room features three large, green, dome-shaped pendant lamps hanging from the ceiling. In the background, there is a large window with a grid pattern, and a red wall is visible on the left. A glass partition or door is also present. The overall style is reminiscent of mid-century modern graphic design.

ALMOST all of us, when we were very young, were given capsules containing cod-liver oil or halibut-liver oil, and sometimes we may have eaten malt containing one or other of these substances. If we thought about this at all, we probably thought it was rather strange, for we were too young to understand that both these oils contain vitamin D. This vitamin is vital to very young children, as without an adequate supply they develop rickets – the deforming disease in which the bones soften and bend and the whole body becomes misshapen.

The cause of this unpleasant childhood illness is now so well understood that, in Britain today, rickety children are almost unknown. But this was not always so. In the past many children suffered from rickets in Britain, as they still do in less developed countries.

The term vitamin D is used to describe two different but closely related substances. One of them, known as vitamin D₂, is made in the laboratory by shining ultra-violet light on a substance obtained from plants called ergosterol. The other, called vitamin D₃,



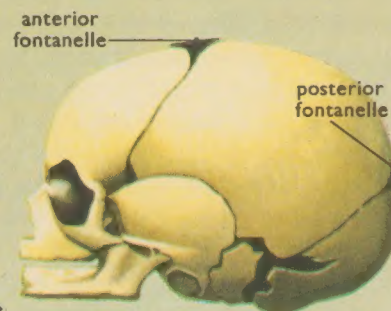
The structural formula of the natural vitamin D₃

The richest sources of vitamin D are the livers of the halibut and the cod, and egg-yolk, milk, and butter are also rich in vitamin D. There is some vitamin D in beef and mutton fat, but none in vegetable fats unless, as in vegetable margarine, it is added during manufacture. Vitamin D is measured in International Units; the daily requirement for an adult human is 250 units, except for pregnant women and nursing mothers who need about twice as much. A pint of milk and an egg-yolk each contains about 50 units; a teaspoonful of cod-liver oil contains 500 units, and of halibut oil 1,500 units.

The fundamental cause of all cases of rickets is a shortage of vitamin D in the tissues, and this deficiency can come about in quite different ways. The most common way is a shortage of vitamin D in the diet, and this often occurs in babies who are fed predominantly on milk for too long. Human milk contains sufficient vitamin D for a very young baby, but the supply becomes inadequate once the child reaches about nine months. Sometimes, although there is enough vitamin D in the diet itself, the infant is unable to absorb it into his body – for example, a diet containing a lot of carbohydrate, especially certain kinds of oatmeal, can interfere with vitamin D absorption. Lastly, a vitamin D shortage is sometimes caused by a lack of sunlight. All children can make some vitamin D for themselves if they get plenty of sunshine.

Rickets is largely a disease of little children, although in some less developed countries older children and even adults suffer from forms of it. However, most of its victims are less than three years old. Because they are so young they are not able to describe their symptoms, but there is no doubt that the illness is a painful one, for the fretful, rickety children lie motionless in their cots and scream whenever they are touched or moved.

As the illness progresses the bony deformities develop. The chest becomes narrow and like that of a pigeon, the legs become bowed, the back bent, and the hole in the bone on the top of the head, called the *anterior fontanelle* (see diagram on the right), which is present in every child at birth, usually fails to close as it should.



An infant's skull showing the open anterior fontanelle

The obvious course adopted in the treatment of rickets is to administer vitamin D in various forms. At the same time the intake of bone-building calcium and phosphorus is increased, usually by making sure that the rickety child has at least two pints of milk each day. Often children are nursed on special sun verandas or exposed to ultra-violet light as shown in the illustration at the top of the page, so that they can make some vitamin D for themselves. Where possible, the bony deformities are reduced or eliminated by the use of splints.

As we have seen, human milk contains sufficient vitamin D to provide an infant with its daily requirements up to the age of nine months. Consequently breast feeding is an excellent way of preventing rickets developing. Today, however, the milk powders which are used for bottle feeding mostly contain added vitamin D and are therefore a perfectly adequate substitute. Even so, it is usual for all babies in Britain and many other countries to be given a daily dose of cod-liver oil to make absolutely certain that they do not develop rickets.

KARL MARX

WORKERS of the world unite. You have nothing to lose but your chains. You have a world to win.' This explosive ending to the *Communist Manifesto* published jointly by Karl Marx and Frederick Engels in 1848 set the tone for a movement which was to revolutionise world politics.

Marx is the founder of Communism. His writings have become the Communist 'bible'. In the name of Marxism governments have been toppled and erected in Russia, China, and most of eastern Europe. Marx is, therefore, one of the most significant figures in history, and has done as much as, if not more than, any other man to shape the world as it is today.

Marx was born on 5th May 1818 into a middle-class Jewish family. His father, a lawyer, was converted to Christianity in 1824, and all his family were baptised as Protestants. Karl studied law, history, and philosophy at Bonn and Berlin universities. In 1841 he received the degree of Doctor of Philosophy.

The young Marx soon adopted a 'radical' approach to politics. This earned him the disapproval of university authorities, which made a university career out of the question for him. To advance his views he took up journalism, and in 1842 became one of the editors of a radical paper. It was suppressed, however, in 1843. That year he married Jenny von Westphalen, the daughter of a high government official who remained remarkably loyal and devoted throughout the tribulations of Marx's turbulent career.

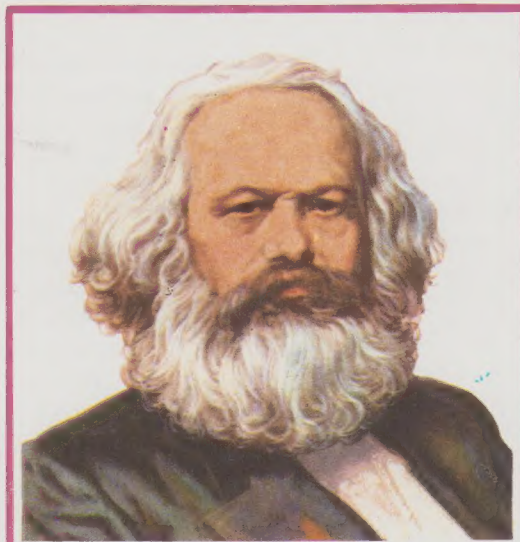
Marx moved to Paris, the centre of advanced socialist thought, where he contributed to a number of left-wing papers and formed a close friendship with Engels. But in 1845 Marx was expelled from France on account of his political views and moved to Brussels. He was soon joined by Engels. In Brussels Marx and Engels set about perfecting and publicising their doctrines. They wrote articles criticising socialists who advocated constitutional methods of achieving power rather than a mass uprising of the oppressed workers to overthrow their governments. They joined a Communist League of German workers and wrote for it the *Communist Manifesto* whose stirring ending we have already quoted. Scarcely was it published when the '1848 revolutions' convulsed all Europe. Marx and Engels hurried to Germany where they founded a daily newspaper subtitled 'an organ of democracy'. They advocated armed resistance against the Prussian government and non-payment of taxes. But the revolutions were soon crushed, and Marx found himself on trial for high treason. He was acquitted but expelled from Prussia. He went to Paris but was soon compelled to leave. Finally he moved to London where he remained for the rest of his life.

Marx in England

Marx's life in England was hard. He and his wife had a few humble rooms in Dean Street, Soho, and all the children born to them in this period died young. Their poverty was relieved by the generosity of Engels. Meanwhile, Marx spent his days in the British Museum poring over books from which he gained a profound knowledge of the economic history of Europe. His studies resulted in the publication, in 1859, of *Zur Kritik der Politischen Oekonomie* and, in 1867, of the first volume of the work for which he is best remembered – *Das Kapital*. His wife remarked that she wished her husband would make some capital instead of writing about it.

After 1864 Marx resumed his political activities. In that year he was one of the founders of the first International. This association of the working men of all countries worked smoothly at first under Marx's guidance. But friction developed largely because of the views of anarchists, who wanted a programme of indiscriminate sabotage and obstruction to government. In addition, the conflicting opinions and prejudices aroused by the Franco-Prussian war of 1870–1871, the civil war in France, and the erection of the Paris Commune in 1871 proved too great to keep the International together. It was formally dissolved in 1876.

Marx's last years were gloomy ones. The death of his wife in 1881 was a blow from which he never recovered, and he died in 1883 with *Das Kapital* still unfinished. He lies buried in Highgate cemetery.



Karl Marx – founder of Communism

Marxism

Marx's teachings were very complicated, and we can give only a brief summary here.

Marx taught that history consisted of a number of fixed stages of development, each of which inevitably gave way before the next. Thus *feudal* society gave way to *capitalism*, and capitalism must, eventually,

give way to *communism*. He therefore expected Communist revolutions to take place in highly developed capitalist countries like England and Germany rather than, say, Russia. In this he was clearly wrong.

Why should each stage of development pass away? Marx considered 'the history of all hitherto existing societies is the history of class struggle'. Such struggles are illustrated by serfs conflicting with their lords and industrial workers with their bosses. Only when Communism should establish a classless society would these struggles cease.

Marx considered that society developed as a result of the material tools of production at its disposal. Thus spears and knives produced a hunting economy; ploughs produced a rural economy on which was erected feudal society; capital and investment produced a capitalist economy; factories and industrial towns produced workers who would one day wrest power from the capitalists and form a Communist society.

Marx thought that the worker was being cheated by his boss. He thought the worker should be entitled to the full value of his labour, instead of which the capitalist made large profits precisely from extra work which was done only for the benefit of the capitalist. This was Marx's famous *theory of surplus value*.

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opens, and the small mature seeds fall out and are dispersed by the wind. Later, when the cone falls, any remaining seeds are carried to the ground.

Broad-leaved trees

As members of the Class Angiospermae, the broad-leaved trees are more closely related to garden plants than they are to the conifers. Furthermore, they have a much shorter history than the Gymnospermae, for they appeared on earth only 150 million years ago.

Best known among British broad-leaved trees are the oak, the ash, and the elm. Like almost all broad-leaved trees that grow in temperate climates, these species are *deciduous* – that is, they shed their leaves each autumn and replace them with new ones in the following spring. The only common evergreen broad-leaved trees in Britain are the holm oak and the much smaller holly and box.

The reproductive organs of the broad-leaved trees are arranged in one or other of three quite different ways. Most species are monoecious like the Gymnospermae, with separate male and female flowers on the same tree. Others, however, are dioecious, the best-known examples being the Lombardy and black poplars. A few trees, of which the elm and the lime are examples, have flowers possessing both male and female structures and are consequently said to be *complete*.

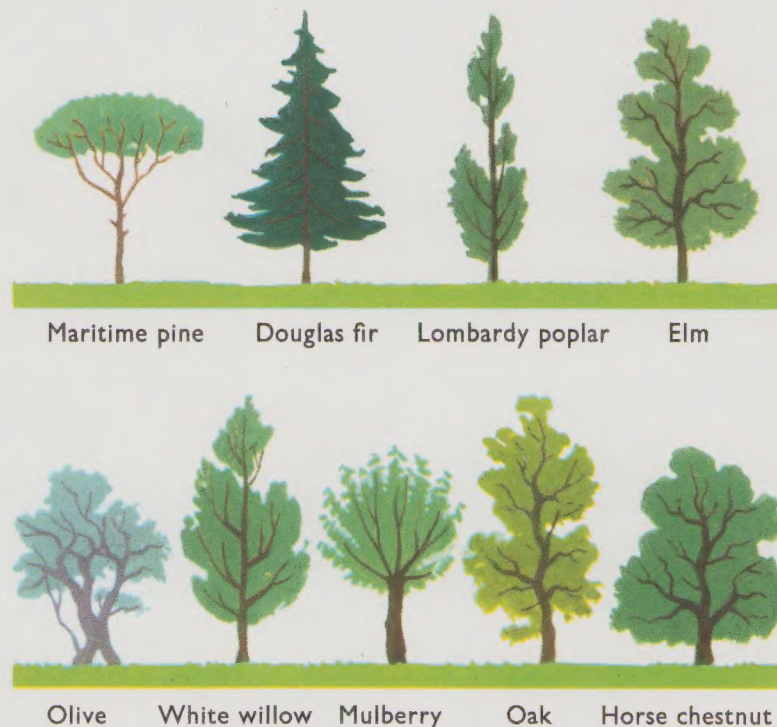
As in the conifers, fertilisation of the broad-leaved trees depends on the carriage of pollen by the wind. But one exception to this rule is the lime tree, which, having both complete flowers and a strong scent, is visited and fertilised by bees. Fertilisation in the Angiospermae, because of the enclosed ovules, is far more complicated than in the Gymnospermae. It takes place by means of a *pollen tube* which grows down the pistil and carries the germ plasm of the pollen grain to the ovule.

The seed-bearing fruits of the broad-leaved trees vary in size from the minute, hairy fruits of the willow to the familiar 'conkers' of the horse chestnut. Seeds with hairs or 'wings' depend on the wind for dispersal, while those with berries depend on birds which eat the fruits and carry the undigested seeds far afield. The largest seeds, such as the chestnut, the acorn, and the hazel nut, seem to rely chiefly on children and forgetful squirrels.

How to recognise the different trees

There is a curious satisfaction in knowing the names of things, including those of trees. And, since so many familiar trees are deciduous, there is an additional challenge in being able to recognise each species as easily in winter as in summer.

Anyone who is really familiar with trees can recognise each species at a glance, regardless of the season. He can do this from a considerable distance, too, because he knows each tree by its *habit* – its general size and shape determined by the way its branches spread outwards from its trunk. Of course, this is easy enough in trees as dissimilar as the Lombardy poplar and the Scots pine, but, at long range, a little more experience is needed to tell an oak from an elm. At close range, however, there are many ways of distinguishing one tree from



another. Many have characteristic bark. The oak and the elm, for example, have hard, rough, deeply furrowed barks, which contrast sharply with the smooth, almost polished barks of the beech and the hornbeam. There are curious spiral bands on the trunk of the sweet chestnut and large patches of white bark on the silver birch.

In summer a single leaf will reveal the species of almost every tree. The narrow 'needles' of the larch, the Scots pine, and the fir are easily distinguished from one another, and they are quite unlike the leaves of the broad-leaved trees, which are also easy to tell apart. Trees can also be identified by their flowers, fruits, and seeds, for in almost every species each of these have characteristic features which are quite unmistakable.

Some notable trees

The tallest tree in the world is thought to be a Californian redwood (*Sequoia sempervirens*) which is over 368 feet high. However, there is a Wellingtonia (*Sequoiadendron gigantea*) known as 'General Sherman' which exceeds it in bulk. This vast tree is over 272 feet high and 101 feet around its bole, and its weight has been estimated at 1,180 tons. It is about 4,000 years old. The baobab tree from tropical Africa is one of the thickest trees, its trunk exceeding 30 feet in diameter. The oldest trees of all are the bristlecone pines (*Pinus aristata*) of California. These were seedlings in about 2600 B.C.

The tallest tree growing in the British Isles is a silver fir, *Abies alba*, at Kilbride in Argyllshire. It is 186 feet 6 inches high. The oldest known tree in the British Isles is the Darley Yew near Matlock in Derbyshire, which has now been growing for about 900 years.

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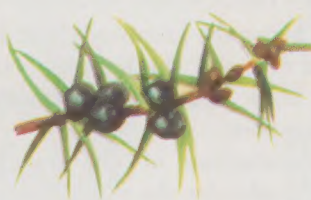
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THE LEAVES OF SOME COMMON CONIFERS, BROAD-LEAFED TREES, AND SHRUBS

 Silver fir	 English maple	 Laurel	 Birch	 Hornbeam
 Sweet chestnut	 Sessile oak	 St Lucie cherry	 Common cypress	 Fig
 Beech	 Ash (single leaflet)	 White beam	 Juniper	 Larch
 Medlar	 Olive	 Elm	 Italian alder	 Walnut (single leaflet)
 Scots pine	 Lombardy poplar	 Gean	 Oak	 Locust tree
 Rose	 Blackberry	 White willow	 Lime	 Grape vine